A STUDY OF SURFACE WARFARE JUNIOR OFFICER RETENTION

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NAVAL POSTGRADUATE SCHOOL
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THESIS

A STUDY OF SURFACE WARFARE JUNIOR
OFFICER RETENTION

by

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A Study of Surface Warfare Junior Officer Retention

by

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The retention of naval officers is often assumed to be independent of the economic circumstances of the individual. This study makes use of classical, normal linear least squares regression techniques and recent surface warfare officer retention data in an attempt to determine whether the retention of lieutenants can be related to a set of economic control variables. In the pursuit of that goal, several previously-developed econometric models which describe first-term enlisted retention are modified for use on officer data and compared for goodness of fit.

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PVM	present value of a military career
PVC	present value of a civilian career
P_j	the basic pay plus allowances of a lieutenant with four years of service in year j
$\bar{w}_j$	the median income of white families in year j
WR_j	the ratio, PVM/PVC
R_{ij}	the retention rate of officers with i years of service in year j
BAS	basic allowance for subsistence
BAQ	basic allowance for quarters
RMC	regular military compensation
IOS	initial obligated service
USNA	United States Naval Academy
NROTC	Naval Reserve Officers Training Corps
E_R	the elasticity of retention with respect to wage ratio
OPNAV	Office of the Chief of Naval Operations

I. INTRODUCTION

A. PRELIMINARY

The Defense Manpower Commission[1] in its April, 1976, Report to the President [1] states:

> There is something to military service beyond pay and benefits; one serves regardless of recognition or appreciation. If this were not so, the professional armed forces of the Western democracies would not have survived the period between the wars. In short, true professionals will serve and fight, even if they believe they are being neglected.

This view, while popular and widely held, does not consider the serviceman to exhibit rational economic behavior. However, consider the April, 1978, Report of the President's Commission on Military Compensation [2]:

> Since the switch to a volunteer force in 1973, the Nation's supply of military manpower has become more dependent on the conditions of the labor marketplace... To attract and retain personnel, changes in compensation policies and personnel management practices became necessary to enable the services to compete effectively with private and other employers.

This second view implies that compensation is a key factor in the retention of military personnel, i.e., the serviceman's decision to select a military career over some other field of endeavor is at least partly based on the economic consequences of such a decision.

This study assumes the position of the second commission; precisely, it is assumed that, when faced with a decision

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[1] Chartered by Public Law 93-155 (Title VII of the DOD Appropriations Act of 1974).

regarding leaving the naval service, each naval officer will compare the present values of all future compensation from the two possible courses of action and select the option with the greater present value. That is not to say that monetary compensation alone is important; certainly, the intangible rewards of military service are also factors in any decision regarding a military career. Yet, the officer must, either consciously or subconsciously, place a monetary value on those intangibles in order to compare the relative values of the two options.

A number of studies, notably [3] and [4], have attempted to describe the factors which affect entrance to and retention in the enlisted community. Moreover, [4] sought with some degree of success to determine the rate of change in retention with respect to military compensation, i.e., to estimate the elasticity of first-term reenlistment rate with respect to military wage. No known study has sought to determine similar elasticities for naval officers who are faced with similar choices regarding a naval career. This study will attempt to establish a functional relationship between naval surface warfare officer retention and a set of economic control variables and use that relationship to determine the elasticity of retention with respect to compensation.

B. DESCRIPTION OF THE DATA

Since FY68, a formatted data bank concerning various naval officer communities has been maintained by OP130, the Officer Plans Section of OPNAV. This bank serves as the source data for officer manpower models used by OP130 to estimate officer strengths by rank, years of service and community. One version of the data extracted from the bank, the so-called "Career Planning Board Version" for surface warfare officers, has been supplied by OP130C4 for use in this study.[2]

The Career Planning Board Version is subdivided into two sections: one lists attritions by rank, years of service and attrition category for FY69-78; the other lists attritions by years of service and attrition category for the same period. This study will use the data of the second section.

Appendix A is a partial reproduction of the pertinent data extracted from the second section of the report.[3] Note that each page in Appendix A refers to surface warfare officers with a given number of years of service (YS = i, i = 2,...,8). Each page lists seven attrition categories:

1. Retirement
2. Release from Active Duty (RAD)
3. Resignation

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[2]This version includes only "due course officers," i.e., officers who have not failed selection to the next higher grade.

[3]That portion of the data set which is not pertinent to this study has been purged in order to simplify data presentation.

4. Death

5. Discharge

6. Community Change

7. Other

Opposite the attrition category, the number of officers who were lost via that category is listed for each fiscal year, 1969-1978. The first three rows of entries (BASES) gives the number of surface warfare officers with YS = i who began each fiscal year according to whether the officers were USN (REG) or USNR (RES) or either (TOTAL). In addition to the attrition data, Appendix B presents a summary table of surface warfare community accessions by fiscal year and years of service.

II. THEORY UNDERLYING THE RETENTION MODEL

A. PRELIMINARY

The goal of this study is to determine whether there exists a functional relationship between retention rates and a set of economic control variables. Toward this end an analysis of the economic situation faced by the naval officer is presented.

B. TASTE AND OPPORTUNITY FACTORS

Consider an officer who has completed his initial obligated service or is approaching that point. The variables which affect his decision to continue to serve or to leave the naval service may be grouped into two broad categories; pecuniary and non-pecuniary. Within the first category are all factors which reflect monetary (opportunity) considerations. It includes such variables as military pay, alternative civilian pay, and other factors which may be expressed equivalently in monetary terms. The second category would include such non-pecuniary (taste) factors as job satisfaction, adaptability to military life, attitudes toward sea duty, and other factors which are difficult to quantify.

In order to make a rational decision in an economic sense, each individual naval officer requires some estimate of the present value of all future compensation from the two courses of action available to him. Let PVM be the present value of

all future earnings realized from a military career and PVC be the present value of all future earnings from an alternative civilian career.

PVM is composed of two types of returns, direct payments such as basic pay and allowances and payments in kind such as medical care and officers club privileges. Within each year group of each specialized officer community, one can assume that PVM for officer A is approximately the same as that for officer B, provided A and B view their prospects for advancement to be the same.[4] Furthermore, since direct military pay is structured according to rank and longevity, a given officer may roughly estimate PVM by speculating on his ultimate pay grade and intended length of service and adding some percentage of direct compensation to cover indirect compensation. Estimating PVC is considerably more difficult.

Among other factors, PVC depends on civilian occupation, education, opportunity for advanced education, labor market stability, and geographical area of employment. Thus, PVC for officer A may bear little relation to PVC for officer B due to a considerable difference in civilian "qualifications" of the two officers. However, if one is willing to make the assumption that the overall educational background and civilian qualifications in a given officer community does not change significantly from one year group to the next (i.e., year group X contains the same proportion of engineers, business

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[4]It can be argued that such an assumption also depends on the relative importance A and B place on payments in kind. The effect of different valuations for payments in kind will be addressed later.

graduates, USNA graduates as year group Y), a method of estimating PVC for a "typical" officer might be developed. However, before beginning that development, the relative importance of the non-pecuniary factors will be examined.

In 1974, the Air Force Human Resources Laboratory published a study on the attractiveness of various non-monetary benefits [2]. Table I is a rank ordering of factors identified as most important in deciding to remain in the Air Force, by the respondent's length of service. For the purposes of this study it is assumed that the results of Table I are equally applicable to naval officers.

TABLE I

Factors Affecting Air Force Retention

Factor	Years of Service				
	0-2.5	2.5-4	4-7	7-13	13+
Job Satisfaction	1	2	1	2	2
Personal Freedom	2	1	3	7*	8*
Cash	3	3	2	3	5
Educational Opportunity	4	5	9	9	8*
Dependent Health Care	5	6	5	4	3
Pay Plus Benefits	6	7	8	6	7
Advancement Opportunity	7	6	4	7*	6
Security	8	4	7	5	4
Retirement	9	9	6	1	1

*Indicates tie

Note that the three most important factors for the 0-2.5, 2.5-4, and 4-7 years of service groups are job satisfacton, personal freedom and cash. Of particular significance is the fact that in the 4-7 years of service group, the group in which the decision regarding career intentions is first faced, cash payment is rated higher (2) than at any other point in an officer's career. The fact that job satisfaction is never ranked lower than second indicates that the issue of job satisfaction is probably moot (if the Air Force did not provide job satisfaction, those who ranked it second in later years would probably have left much earlier). Moreover, of the five highest ranked factors in the 4-7 years of service category, probably only one (cash) showed much variation over the 1969-1978 time frame, the period of interest in this study. Consequently, given that a set of taste or personal preference variables affect retention rate, one would expect that for each year group in question the overall effect of those preferences was essentially constant. Therefore, the problem of quantifying the taste factors can be eliminated provided the model is properly specified.

Table I also shows that payments in kind (dependent health care, educational opportunity, pay plus benefits) receive relatively low rankings in the 0-7 years of service range. When viewed in the context of utility maximization, the fact that payments in kind are ranked far below cash payments is logical. Since payments in kind are non-transferable, they are discounted below their true market value, i.e., $300 in housing is worth less to an individual than $300 in cash

because the cash has greater utility. This fact would support the earlier statement regarding the comparability of PVM for the two officers A and B. Since payments in kind are generally ranked toward the bottom of the scale, PVM for A should not be significantly different from that for B, even if A placed a somewhat greater value on such payments. Furthermore, it can be argued that junior officers, because of their relatively good health, small family size, and less restricted lifestyles, tend to underestimate the value of fringe benefits, military or civilian.

C. PRESENT VALUE ESTIMATION

Let P_j be the annual pay (basic pay plus allowances) of a lieutenant who begins year j, j = 1969,...,1978, with exactly four years of service.[5] Let b_j be the value of the benefits received by the lieutenant in year j. Define w_j as the annual wage (annual pay plus benefits) that the lieutenant receives during the fifth year of service so that

$$w_j = P_j + b_j \qquad j = 1969, \ldots, 1978$$

If b_j can be expressed as some constant percentage, p ($p > 0$), of pay then

---

[5] It can be argued that the tax savings realized on allowances should be included in P_j; its exclusion will be addressed later. The rationale behind the selection of the four year point in a given lieutenant's career will also be addressed later.

$$w_j = (1 + p)\ P_j$$

Since military pay scales are structured by years of service and rank, the officer's annual military wage, wm(t), in some future year t, t = 0,..., T, may be expressed as a multiple of w_j, or

$$wm(t) = w_j\ sm(t)$$

$$= (1 + p)\ P_j\ sm(t) \qquad j = 1969,\ldots,1978$$

$$t = 0,\ldots, T$$

where sm(t) is a step function. Consequently, the present value of all future compensation realized by a lieutenant who enters year j with four years of service, PVM_j, may be obtained by summing his discounted annual wage, $\frac{wm(t)}{(1+r)^t}$, over all t. Thus,

$$PVM_j = \sum_{t=0}^{T} \frac{wm(t)}{(1+r)^t} = \sum_{t=0}^{T} \frac{(1+p)\ P_j\ sm(t)}{(1+r)^t} \qquad (1)$$

where r is the discount rate. Now, consider the civilian alternative occupation. Let W_{ij} be the entrance wage for occupation i, i = 1,..., n, in year j, and let $\overline{w}_j$ be the median wage of some occupational cross-section in year j. Suppose that the supply and demand for entrants into occupation i does not change with respect to that for the other occupations that make up the cross-section, so that for any entrance year j,

$$W_{ij} = c_i\ \overline{w}_j$$

for some constant c_i associated with occupation i. Let $sc_i(t)$, t = 0,..., T, be the wage growth rate for occupation i. Then

the wage for i at some future time t, $wc_i(t)$, is given by the entrance wage times the wage growth rate evaluated at t, or,

$$wc_i(t) = W_{ij}\, sc_i(t)$$
$$= c_i\, \bar{w}_j\, sc_i(t)$$

Since all officers leaving the service do not select the same civilian occupation, it is necessary to generalize c_i across all occupations. For want of a better method, assume the existence of a "typical" constant, c, and a typical wage growth rate, sc(t), so that

$$PVC_j = \sum_{t=0}^{T} \frac{c\, \bar{w}_j\, sc(t)}{(1+r)^t} \tag{2}$$

is the present value of the discounted future compensation for a typical civilian alternative, given entrance in year j.

Now, define

$$WR_j = \frac{PVM_j}{PVC_j} = \frac{\sum_{t=0}^{T} \frac{(1+p)\, P_j\, sm(t)}{(1+r)^t}}{\sum_{t=0}^{T} \frac{c\, \bar{w}_j\, sc(t)}{(1+r)^t}} \tag{3}$$

as the present value ratio for a typical lieutenant who enters year j with four years of service.

Concerning the right hand side of equation (3), P_j and $\bar{w}_j$, alone, vary over j, j = 1969,..., 1978, providing the military and civilian wage growth rates and the discount rate remain constant during the period of interest. Consequently, WR_j might be considered to be a function of P_j and $\bar{w}_j$. Therefore, one might expect that PVM_j is correlated with P_j and PVC_j is

correlated with $\bar{w}_j$. The significance of such a correlation will become apparent in the next section.

D. DEVELOPMENT OF THE MODEL

Gray [5], Fisher [6], Nelson [7], and Wilburn [8] have all proposed models for enlisted first-term retention of the form

$$R = f(\frac{PVM}{PVC})$$

where R is the retention rate. Specifically, Fisher concluded that the appropriate model was

$$R = \alpha + \beta \ln(\frac{PVM}{PVC}) + \varepsilon \tag{4}$$

where ε is a normally distributed error term. Nelson proposed

$$\ln(R) = \alpha + \beta \ln(\frac{PVM}{PVC}) + Z + \varepsilon \tag{5}$$

where Z is an additional set of variables used to stratify a mixed group of enlisted personnel (e.g., separate ET's from BT's). The choice of the set Z, therefore, depends on the degree of aggregation desired in defining a particular group of enlisted personnel. Gray and Wilburn chose to use a logit transformation to express the estimate in "odds" form rather than as a straight probability; hence, the following model:

$$\ln(\frac{R}{1-R}) = \alpha + \beta \ln(\frac{PVM}{PVC}) + Z + \varepsilon \tag{6}$$

Altergott [4] attempted to modify the above models in order to allow for his supposition that a given individual might place a higher value on a change in, say, PVC than he would in

an identical change in PVM; thus, he would not value the dollars in PVM and PVC in a constant ratio. Consequently, Altergott proposed a present value ratio of the form

$$WR = \left(\frac{PVM}{PVC^{d}}\right) \tag{7}$$

where d is a constant.

It should be noted that all of the models listed above were designed for use in enlisted communities, communities where the military skill of the serviceman is often directly related to a similar civilian skill. Consequently, the determination of PVC is somewhat easier and more correct than the procedure previously proposed for estimating an officer's PVC. In fact, due to the problems associated with computing PVM and PVC, an attempt will be made to introduce instrumental variables in place of PVC and PVM.

Consider a linear least-squares model of the form:

$$Y_i = \alpha + \beta X_i + \varepsilon \tag{8}$$

where X_i is measured with error v_i. The observed value of the control variable is $X_i' = X_i + v_i$. Because of the measurement error, the actual regression would be

$$\begin{aligned} Y_i &= \alpha + \beta X_i' + (\varepsilon_i - \beta v_i) \\ &= \alpha \quad \beta X_i' + \varepsilon_i' \end{aligned}$$

instead of the desired equation (8). Since the control variable is correlated with the error term, the least squares estimates of the regression parameters will be biased and inconsistent.

The method of instrumental variables [11] specifies substituting a new control variable V_i which is both highly correlated with the independent variable and uncorrelated with the error term. Consequently, the use of such an instrument gives consistent estimates for the regression parameters.

Equations (1) and (2) suggest that P_j and $\overline{w}_j$ are candidate instruments for PVM and PVC, respectively. The models postulated in equations (4) through (6) will be modified to accommodate the instruments for PVM and PVC in the applications chapter of this study. Also, other possible models will be developed and compared for goodness of fit. First, however, some additional analysis of the candidate instruments is in order.

E. P_j AND $\overline{w}_j$, 1967 TO 1978

Consider the military pay structure. Military pay is divided into three basic categories: basic pay, allowances, and special pay. Rates of basic pay, the primary means of compensating members of the uniformed services, are legislated by Congress and are dependent on both pay grade (rank) and total years of service. Basic Allowance for Quarters (BAQ) and Basic Allowance for Subsistence (BAS) are also legislated, but eligibility is somewhat more complicated. All officers draw the same BAS, regardless of rank; however, BAQ rates depend on rank, whether an officer has dependents, whether government quarters are utilized, and, in the case of single officers, type of duty. Special pay, such as submarine duty pay, aviation career

incentive pay, and diving pay, depends on rank and/or years of service and type of duty; special pay does not, in general, apply to surface warfare officers.

By virtue of their categorization as allowances, BAS and BAQ are not taxable as personal income; consequently, the officer drawing such allowances realizes a certain tax advantage. That tax advantage is added to basic pay, BAS, and BAQ, and the total is termed Regular Military Compensation (RMC). RMC is then used as a benchmark by which to measure the true cash compensation of servicemen.

Since BAQ rates vary by dependency status and type of duty as well as rank, the actual RMC realized by officers of equivalent rank and years of service varies significantly. Consider the 1976 pay of three lieutenants with more than four years of service, none of whom utilized government quarters: one (A) married and serving at sea; one (B) single, without dependents, serving ashore; and one (C) single, without dependents, serving at sea. Each lieutenant received $14,090.40 in basic pay and $644.28 in BAS. However, A received an additional $2,677.50 in BAQ, B received $2,169.90, and C received no BAQ. Table II shows the tax savings realized by each officer and his RMC, based on 1976 federal income tax schedules with standard deduction.

TABLE II

RMC Comparisons

Lieutenant	Taxable Income	Non-Taxable Income	Tax Savings	RMC
A	$14,090.40	$3,321.78	$837	$18,249.18
B	14,090.40	2,814.18	876	17,780.58
C	14,090.40	644.28	189	14,923.68

Moreover, since federal income tax rates are graduated by taxable income levels, the existence of other types of deductions (interest expense or property taxes) would cause increased variations in RMC. Finally, variations in income tax rates among the states would also increase the variations in RMC.

Unless one is able to categorize the officers who left or remained in the service by actual RMC, the variations in RMC according to dependency status and type of duty complicate any attempt to formulate an econometric model for retention, given cash compensation as an instrument for PVM. Unfortunately, such a categorization is not feasible with the data available, and some figure representative of the officer group as a whole must be chosen. This study will assume that the basic pay plus BAS plus BAQ for a lieutenant with dependents and more than four years of service is representative of the RMC of a typical officer, and this figure will be used for P_j.

The problems associated with computing PVC for a diverse officer community have been previously discussed; the problem of selecting a suitable cross-section to obtain a value for $\bar{w}_j$ is also difficult. The availability of income statistics

for the type of alternative white collar occupations that a naval officer might select is inadequate for the 1969-78 time frame. The median annual income of white families, possibly multiplied by a constant, will be used to represent $\bar{w}_j$ for the period, the selection of this level of income being made as much of necessity as of choice.

Figure 1 is a graphical representation of P_j and $\bar{w}_j$, $j = 1967, \ldots, 1978$. Here both P_j and $\bar{w}_j$ have been adjusted to constant 1976 dollars using the consumer price index for urban wage earners and clerical workers. Appendix C gives the same information in tabular form.

With the introduction of the all volunteer force concept, military pay was raised "to reasonably competitive levels for the first time in recent history" according to a report submitted to Congress in compliance with 37 USC 1008(a) on the adequacy of military pay and allowances [2]; hence, the greatest difference between P_j and $\bar{w}_j$ occurred during 1972 ($P_{1972} = 1.23\ \bar{w}_{1972}$). However, by 1978 the differential had been reduced by approximately 65%, perhaps due to the fact that military wage adjustments for the effects of inflation were somewhat less than those for the civilian wage earners.

Now, consider the effects of the variation of the wage ratio, $\frac{P_j}{\bar{w}_j}$ from 1967 to 1978 (Figure 2). Between 1967 and 1972, that ratio first declined until 1970 when it began a steep climb, peaking at 1.23 in 1972. However, after 1972, the wage ratio steadily declined to 1.09 in 1978. Thus, by

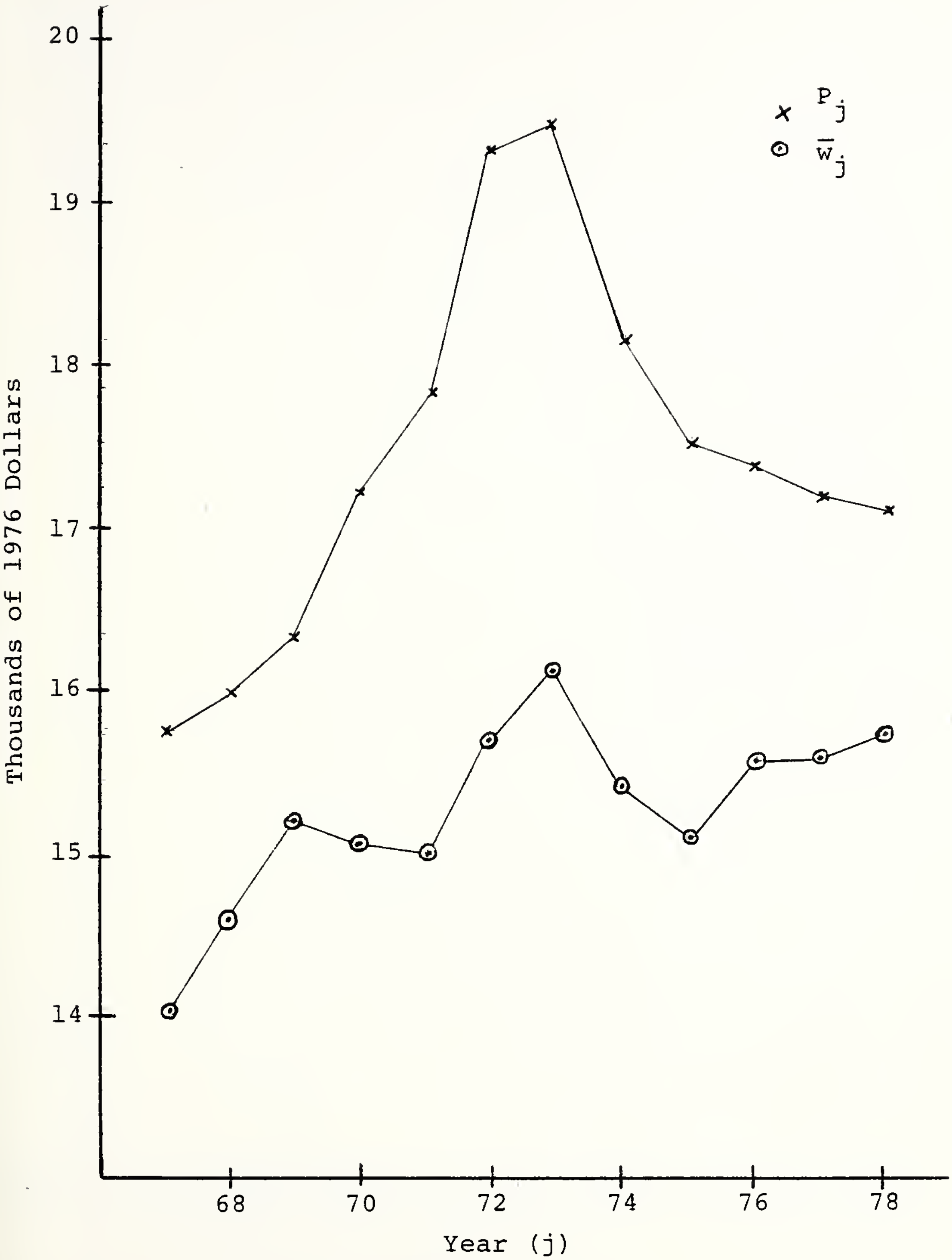

Figure 1. P_j and $\overline{w}_j$ vs j

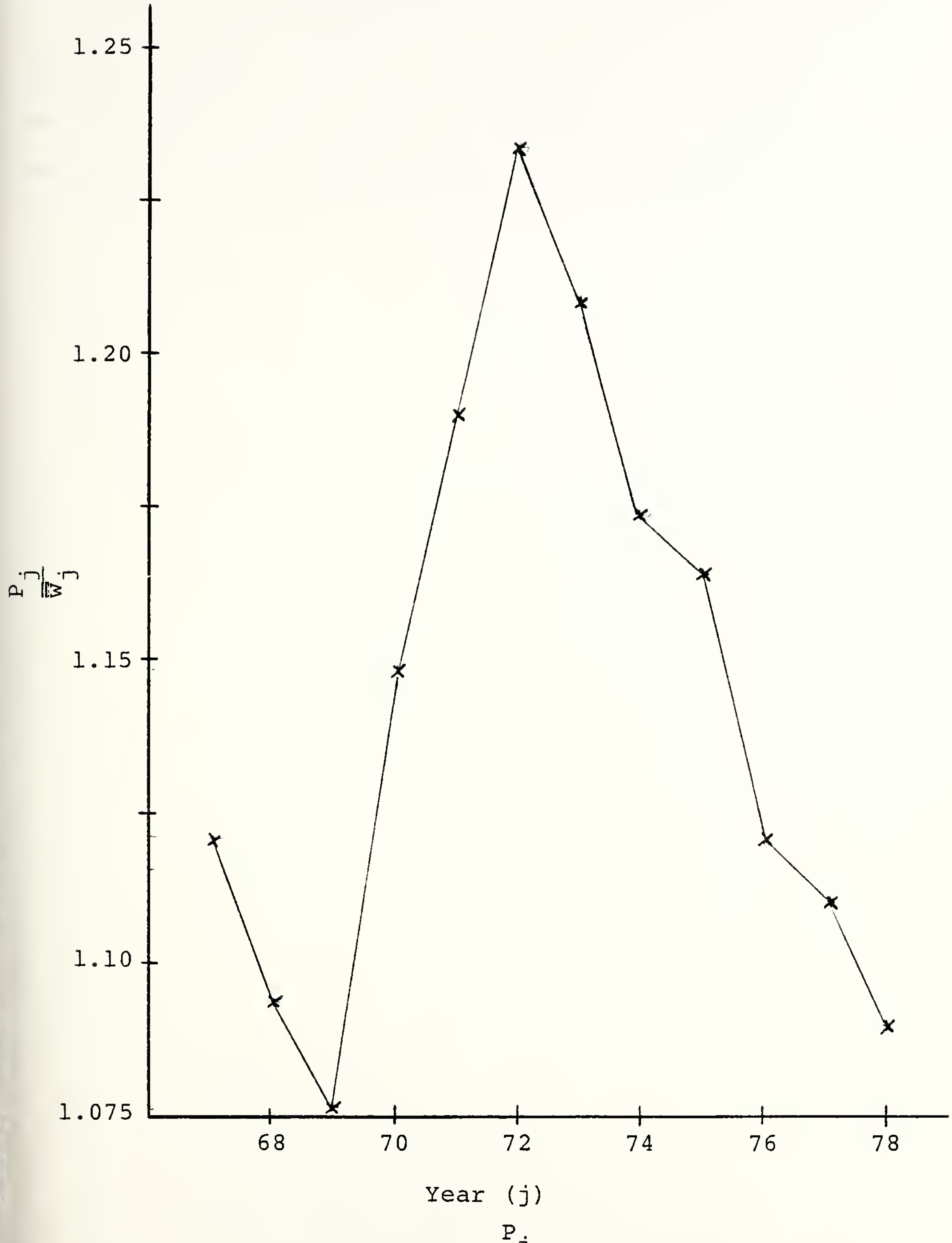

Figure 2. $\frac{P_j}{\overline{w}_j}$ vs j

1978, all of the real military pay gains of the early seventies had been absorbed by inflation, and the economic position of a lieutenant in 1978 was no better than that of a lieutenant in 1968-69. In fact, in 1978, an 0-4 (over 10) received about the same real pay as did an 0-3 (over 4) in 1972; consequently, real pay did not increase with longevity and promotion.

III. DATA ANALYSIS

A. PRELIMINARY

During the period 1969 to 1978, a number of significant events occurred which directly or indirectly affected naval officers; here, these will be called environmental factors. First, the number of surface ships (less mine warfare) declined from 703 in 1969 to 314 in 1978. Second, the naval involvement in the Vietnam conflict peaked in 1972 and then declined until the evacuation in 1975 ended the Navy's role. Third, military conscription ended in 1972 with the shift to an all volunteer force. Each of these events could have some effect on an individual's decision to enter the Navy or to pursue a naval career; consequently, in using officer retention data for the period, some allowance should be made for the effects of such events, or some assumptions regarding the net effect of the events must be postulated. This chapter will examine the retention data in light of these events and develop heuristic arguments for any necessary adjustments to the data base. Before beginning that examination, some preliminaries are necessary.

For the purposes of this study, the following assumptions are made concerning the attrition categories of Appendix A:

1. Only USN officers resign from the service.

2. Only USNR officers are released from active duty (RAD).

3. Both USN and USNR officers may be lost via any one of the remaining five attrition categories.

Regarding the initial obligated service (IOS) requirements of USN and USNR officers, assume:

1. USN officers enter with four years IOS.[6]

2. USNR officers enter with three years IOS.

Differences exist in the way enlisted servicemen and officers extend their length of service beyond their IOS; consequently, additional clarification regarding officer retention is required. Enlisted personnel and USNR officers must initiate action (reenlistment for enlisted, extension of obligated service for USNR officers) to remain beyond their IOS. USN officers, however, serve until they initiate action (resignation) to leave. Thus, enlisted personnel and USNR officers essentially renew their contracts with the Navy for a particular length of time while USN officers may resign at any time beyond the end of their obligated service. In applying the "first term" retention models to the case of officers, a definition of "first term" retention is necessary.

The data in Appendix A show that, of those USN officers who left the service before completing their tenth year, a majority left before beginning their seventh year of service. This study will, therefore, be concerned with the retention of USN officers with six or fewer years of service and USNR officers with five or fewer years of service. Consider such retention to be "first term."

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[6]The IOS requirement for USNA entrants changed from 4 to 5 years beginning with the USNA Class of 1969. The net effect of such a change will be addressed later.

B. ENVIRONMENTAL FACTORS

The most important environmental change affecting the surface warfare community during the 1970's was the drastic reduction in the number of surface units. Figure 3 illustrates the reduction. The reduction was brought about by the desire of the Navy to cut operating expenses in order to have the necessary funds available for fleet modernization.[7] Such a reduction in ships left the Navy with a surplus of surface warfare officers; and, since junior USNR officers are the easiest to eliminate, the USNR segment of the surface warfare community experienced heavy losses, particularly during the FY69-73 period when 285 of the eventual 389 ships were retired.[8] Thus, during the early part of the seventies, many USNR officers with 2, 3, 4 or 5 years of service were forced into the civilian community and their decision regarding a naval career was somewhat moot.

The decisions of USN officers regarding continuing in the service were affected in more subtle ways. Ship retirements reduced sea tour opportunities (or, conversely, increased shore duty opportunities) for USN officers so that the overall effect on a given USN officer would depend on the relative values he placed on sea duty and shore duty. During the same period increased emphasis was placed on officer subspecialties

[7]One might say that a reduction in operating budget rather than fleet size was the most important factor; however, the effect was the same.

[8]348 of 460 if one includes mine warfare vessels.

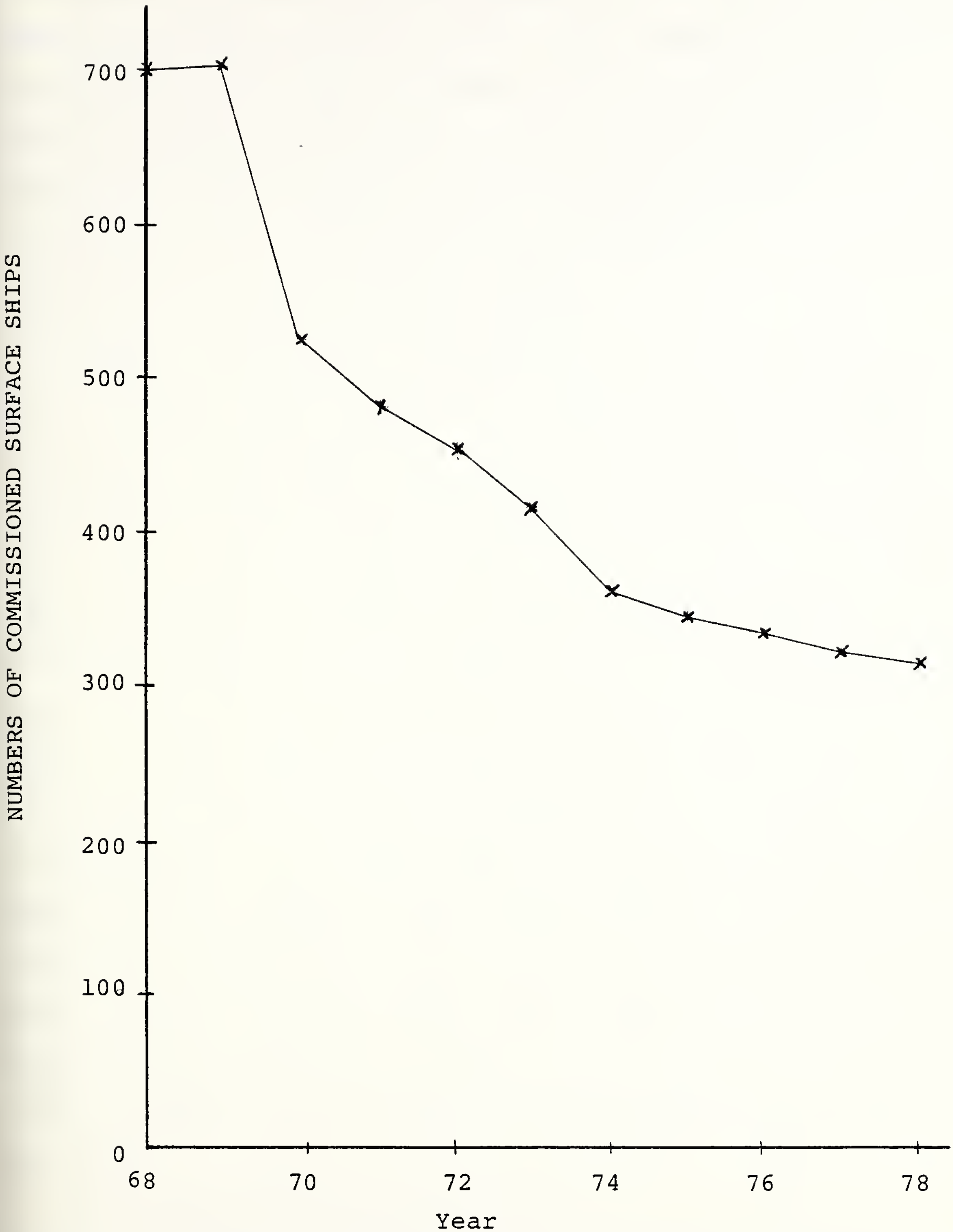

Figure 3: Numbers of Commissioned Surface Ships (1968-1978)

and less traditional avenues of advancement; thus, the amount of sea duty necessary for advancement also declined. The introduction of a number of new surface units, notably the FF-1052 class, and the retirement of many of the aged fleet units tended to increase the overall quality of sea duty while the quantity declined. Finally, since USN officers were not forced to resign, the USN officer was still able to choose to continue; such was not the case for many USNR officers.

Another environmental factor was the end of the draft in 1972. Without doubt, many of the USNR officers, if not most, who entered naval service prior to 1973 did so to avoid being conscripted into the Army and had no intention of serving beyond their IOS. While some came to thrive in the Navy and developed career intentions, the majority probably never seriously considered a military career. On the other hand, USN entrants prior to 1973 should have been at least partially motivated toward a career, given that there were easier and quicker ways to fulfill their military service obligations. Moreover, due to the length of the pipeline for USN entrants (4 years for NROTC and USNA graduates), any effect on USN retention from the draft's end would not be realized until 1980 (1972 plus four years pipeline plus four years IOS). USNR officer retention would have been effected as early as late 1975 since all USNR entrants after 1972 were joining the Navy rather than avoiding the Army.

The ordinary least squares models of this study require, among other things, a normally distributed error term with zero mean and constant variance. While it is doubtful that

the environmental changes of the seventies had a serious effect on the USN data, it is obvious that the effect on USNR officers was considerable and that the USNR data is not readily usable. Almost certainly, USNR officers were so influenced by the changing environment that the continuation decision of a USNR officer in, say, 1973 bore little relation to that of a similar officer in 1978. Consequently, an error term with constant variance is highly improbable for a regression based on the USNR data available. Since no suitable method of adjusting the USNR data to eliminate the environmental effects could be devised, the remainder of this study will concentrate on USN surface warfare officer retention, alone.

C. ADJUSTMENTS TO THE DATA

A perusal of Appendices A and B will demonstrate several deficiencies in the data.

First, it can be verified that the various officer attrition categories and the list of accessions do not fully account for all officer losses and gains. For example, Appendix A lists a beginning strength of 648 USN (REG) officers with YS = 4 in 1970. For that same year, 158 officers are shown to have resigned their commissions. Barring a loss of any USN officers from the remaining six possible attrition categories, one would expect 648-158, or 490, USN officers with YS = 5 to begin 1971. However, Appendix A shows 534 USN officers with YS = 5 began 1971. Some regular officers could have been gained from other communities; however, Appendix B lists only 11 officers

(USN and/or USNR) as accessions. Even if one assumes that all accessions were USN, 534 - (490+11), or 33, of the officers gained are unaccounted for. It is also possible that some of the USNR officers augmented to USN during 1970; however, only 4 of the USNR officers (195 USNR with YS = 4 in 1970 minus 35 RAD implies 160 USNR officers should begin 1971 versus the 156 shown by Appendix A) could have contributed to the 1971 USN total with YS = 5. Also, it should be noted that another 7 officers (USN and/or USNR) with YS = 4 were lost through the other attrition categories so that the USN discrepancy might be as high as 51.

Second, Appendix B shows extremely high numbers of accessions during 1975 of officers with 1, 2, 3 and 4 years of service. The most reasonable explanation for these abnormal accessions is that some of the accessions are actually "inventory" gains due to an earlier classification error, i.e., some surface warfare officers were actually placed in the wrong community in earlier years and the mistake corrected in 1975. No matter what the reason for the abnormal accessions, the net effect is to bloat the USN officer bases for 1976 and 1977 and, probably, to bias the retention rate upward.

Third, between FY76 and FY77, a temporary fiscal year was added, FY7T. This three month addition was implemented to allow the military to shift from a July-July fiscal year to an October-October fiscal year. Here, data for FY7T will be combined with that for FY76 and suitable adjustments made for the extra three months.

Finally, surface warfare officers did not exist as a community separate from other 11XX officers prior to 1972. With the creation of a separate community for surface warfare, it was necessary to alter the data base prior to 1972 to reflect what was later to become that community. Consequently, some errors may have been introduced at the time the pre-1972 data was updated.

These four data deficiencies require a careful construction of the retention or loss rate figures to be used in the regression analysis. In particular, the first deficiency requires one to choose between accepting the numbers of resignations listed or computing some net resignation figure. The second option will be taken; precisely, the overall officer net loss figure will be used for USN officers. That net loss figure will be determined in the following manner:

Let S_{ij} be the beginning strength of USN officers with YS = i in year j. Let LN_{ij} be the net loss of USN officers with YS = i during year j. Then,

$$LN_{ij} = S_{ij} - S_{(i+1)(j+1)} \qquad i = 4, 5 \quad j = 1970, \ldots, 1977$$

Also, define LN_j as the net number of USN officers lost during the fifth <u>and</u> sixth year of service, given j as the year in which the fifth year of service was entered (i.e., LN_j is the net "first-term" loss). Thus,

$$LN_j = S_{4j} - S_{6(j+2)} \qquad j = 1970, \ldots, 1976$$

Table III list S_{4j}, S_{5j}, S_{6j}, LN_{4j}, LN_{5j}, and LN_j for the period of interest.

Net retention rates for USN surface warfare officers can be computed directly from Table III. Define R_{4j} as the net retention of USN surface warfare officers who enter year j with YS = 4 (group SW4) and R_{5j} as the net retention of USN surface warfare officers who enter year j with YS = 5 (group SW5). Also, define R_j as the net "first term" retention of USN surface warfare officers during their fourth through fifth year of service (group SW4,5), given YS = 4 in year j. Thus,

$$R_{4j} = \frac{S_{4j} - LN_{4j}}{S_{4j}} \qquad j = 1970, \ldots, 1978$$

$$R_{5j} = \frac{S_{5j} - LN_{5j}}{S_{5j}} \qquad j = 1970, \ldots, 1978$$

$$R_j = \frac{S_{4j} - LN_j}{S_{4j}} \qquad j = 1970, \ldots, 1977$$

Figure 4 illustrates R_{4j}, R_{5j}, and R_j for the period of interest.

TABLE III: NET LOSS DATA

j	S_{4j}	S_{5j}	S_{6j}	LN_{4j}	LN_{5j}	LN_j
1970	648	481	451	114	43	224
1971	528	534	438	83	110	97
1972	540	445	424	5	14	13
1973	668	535	431	31	8	105
1974	795	637	527	102	74	214
1975	696	693	563	*	112	*
1976	795	736	581	*	191	*
1977	809	819	545	140	195	339
1978	786	669	624	112	199	-
1979	964	674	470	-	-	-

*Because of the abnormal accessions in 1975, $LN_{4(1975)}$ and $LN_{4(1976)}$ are actually net gains; these figures are omitted.

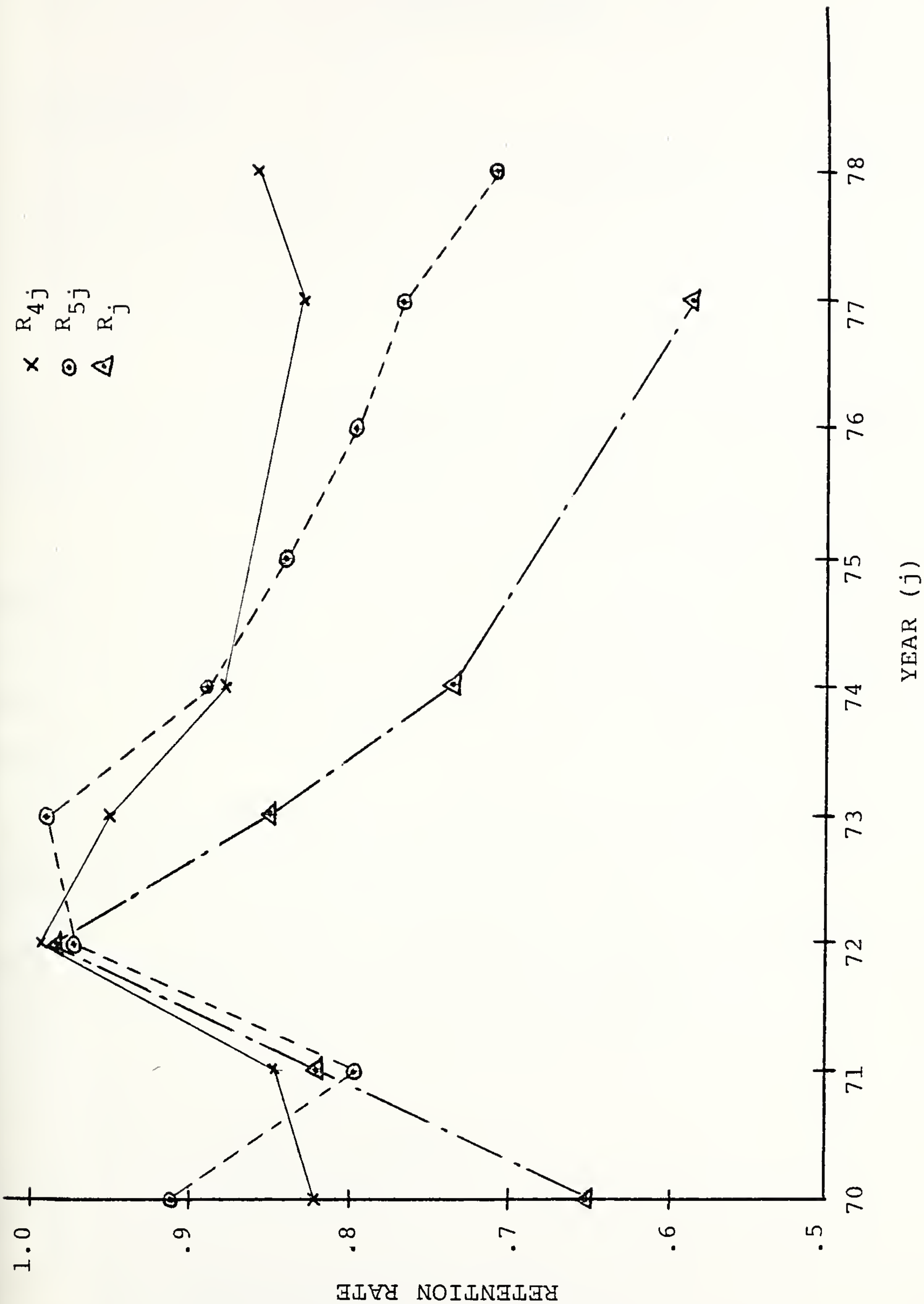

Figure 4: Retention Rate vs Time

IV. APPLICATIONS

A. PRELIMINARY

Recall the classical, normal linear least squares model of a time series relationship:

$$Y_t = \alpha + \beta X_t + \varepsilon_t$$

Apart from the implicit assumption that Y_t is linear in X_t, certain other assumptions apply, including:

1. Normality: The dependent variable is assumed to be normally distributed.

2. Independence: For any two observations on the dependent variable, say Y_t and Y_{t+k} $(k \neq 0)$, Y_t is assumed to be independent of Y_{t+k}.

3. Homoscedasticity: The dependent variable observations are assumed to have the same variance, γ_Y^2.

Under these assumptions the Maximum Likelihood Estimators (MLE) of α, β, and ^2_Y can be shown [9] to be given by:

$$\hat{\alpha} = \bar{Y} - \hat{\beta}\,\bar{X} \tag{9}$$

$$\hat{\beta} = \frac{\sum_t X_t Y_t - N\,\bar{X}\,\bar{Y}}{\sum_t X_t^2 - N\,\bar{X}^2} \tag{10}$$

$$\hat{\gamma}_Y^2 = \frac{1}{N-2} \sum_t \left(Y_t - \hat{\alpha} - \hat{\beta}\,X_t\right)^2 \tag{11}$$

Furthermore, it can also be shown [9] that these maximum likelihood estimators for α ($\hat{\alpha}$) and β ($\hat{\beta}$) are normally distributed:

$$\hat{\alpha} \sim \text{Normal}\left(\alpha, \frac{\gamma_Y^2 \sum_t X_t^2}{N \sum_t (X_t - \overline{X})^2}\right) \tag{13}$$

$$\hat{\beta} \sim \text{Normal}\left(\beta, \frac{\gamma_Y^2}{\sum_t (X_t - \overline{X})^2}\right) \tag{13}$$

Knowledge of the distribution of the estimators permits the construction of t-statistics which may be used to test the significance of the parameter estimates [9].

Apart from testing the significance of the regression coefficients, themselves, two additional statistics are usually specified for use in evaluating the goodness of fit of the overall regression model. The first, statistic, R^2, is the proportion of the variation among the observed values of the dependent variable that is explained by the regression model; the second statistic, an F-statistic, can be used to test the significance of the R^2 statistic.[9] Equations (14) and (15) are the defining relationships for the R^2 and F statistics, respectively; these equations are presented without elaboration.[10]

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[9] Actually, the F-statistic tests the null hypothesis, H_0: $\alpha = 0$ and $\beta = 0$.

[10] See [9] or [11] for the derivation of these equations.

$$R^2 = 1 - \frac{\sum_t \hat{\varepsilon}_t^2}{\sum_t (Y_t - \overline{Y})^2} \tag{14}$$

$$F_{k-1,\ N-k} = \frac{R^2}{1 - R^2} \frac{N - k}{k - 1} \tag{15}$$

Where: $\hat{\varepsilon}_t = Y_t - \alpha - \beta\ X_t$

k = number of control variables plus 1

N = number of observations

In the case of time series models such as those of interest in this study, heteroscedasticity is unusual because changes in the dependent variable and a change in the control variable are likely to be of a similar order of magnitude. Moreover, given the small number of observations available, heteroscedasticity, if present, would be difficult to detect. Here, unless an examination of the residuals shows a marked pattern of increasing or decreasing magnitudes over the period of the observations, homoscedasticity will be accepted.

Time series, however, are very susceptible to the effects of serial correlation; and, since serial correlation would violate the assumption of independence, the absence of serial correlation must be verified or the model modified to negate its effect. The Durbin-Watson Test [10] will be used to detect the presence of serial correlation. That test specifies the use of a test statistic, DW, which is based on the residuals from the ordinary least squares regression procedure. The

Durbin-Watson statistic is defined:

$$DW = \frac{\sum_{t=2}^{T} (\hat{\varepsilon}_t - \hat{\varepsilon}_{t-1})^2}{\sum_{t=1}^{T} \hat{\varepsilon}_t^{\,2}} \tag{16}$$

Unfortunately, tables for the Durbin-Watson test are not available for regressions based on fewer than 15 observations so that a straight-forward application of the statistic is not possible for the regressions used in this study. Pindyck and Rubinfeld [11] have shown that, after several simple approximations, the test statistic is approximately equal to $2(1 - \hat{\rho})$, where $\hat{\rho}$ is the estimate for the correlation between Y_t and Y_{t-1}. Consequently, an approximation for the correlation coefficient can be obtained:

$$\hat{\rho} \simeq 1 - \frac{DW}{2} \tag{17}$$

Since $-1 \leq \rho \leq 1$, equation (17) indicates a Durbin-Watson of 2 would imply the absence of serial correlation.

Given $\hat{\rho}$ from equation (17) as a departure point, the Hildreth-Lu Procedure [12] may be used to determine how the total sum of the squares of the residuals varies with ρ; hence, the overall effect of the presence of serial correlation, if any, can be determined. The Hildreth-Lu Procedure specifies performing the regression:

$$(Y_t - \rho Y_{t-1}) = (1-\rho) + (X_t - \rho X_{t-1}) + (\varepsilon_t - \rho\varepsilon_{t-1}) \tag{18}$$

for a set of grid values around $\hat{\rho}$ and selecting the grid value

which gives the smallest residual sum of squares as the best estimator for ρ. Although the above procedure does not give firm statistical results, its use will allow an evaluation of the effect of any serial correlation, and, hence, an evaluation of the appropriateness of the independence assumption.

B. LINEARITY

Each of the models previously discussed (equations (4), (5), and (6)) specify that the dependent variable be linear in a single independent variable. For ease of presentation and analysis, the proposed instruments for PVM_j (P_j) and PVC_j ($\overline{w}_j$) will be incorporated into the models and the models will be labeled M1, M2, and M3. Specifically, denote:

M1: $R_j = \alpha + \beta \ln(\frac{P_j}{\overline{w}_j}) + \varepsilon_j$ linear

M2: $\ln(R_j) = \alpha + \beta \ln(\frac{P_j}{\overline{w}_j}) + \varepsilon_j$ log linear $R_j = e^{\alpha + \beta \frac{P_j}{\overline{w}_j}}$

$\varepsilon = \beta$

M3: $\ln(\frac{R_j}{1 - R_j}) = \alpha + \beta \ln(\frac{P_j}{\overline{w}_j}) + \varepsilon_j$ logit

For reasons that will become apparent, a fourth model, M4, will be considered; denote:

M4: $R_j = \alpha + \beta \frac{R_j}{\overline{w}_j} + \varepsilon_j$

Before continuing to the actual statistical analysis of these four models, a preliminary evaluation of the appropriateness of the linearity assumption may be made by plotting the

dependent variable for each model against its independent variable. Figures 5, 6, 7, and 8 illustrate such plots for M1, M2, M3 and M4, respectively, using fifth year retention data points (i.e., R_{5j} for group SW5) for the period.

Although not shown, identical plots using fourth year retention data points (R_{4j} for group SW4) and overall "first term" data (R_j for group SW4,5) give similar results, except plots based on the M1 relationship do not support linearity. Consequently, M1 will be eliminated from further consideration in favor of M2, M3 and M4.

C. STATISTICAL ANALYSIS

Linear least squares regressions were performed using models M2, M3 and M4 on net retention data for regular surface warfare officers with four but less than five years of service (group SW4), five but less than six years of service (group SW5), and four but less than six years of service (group SW4,5). The regression results and appropriate statistics are reported in Table IV. Consider those statistics.

Reference to a table of the standard t-distribution verifies that $t_\alpha \geq 2.571$ specifies rejecting the two-tailed null hypothesis (H_0: $\alpha = 0$) at the 0.05 level of significance with N = 6, and $t_\beta \geq 2.571$ specifies rejecting the two-tailed null hypothesis (H_0: $\beta = 0$) at the 0.05 significance level with N = 6. Consequently, a reported t-statistic ≥ 2.571 for both α and β would support a given model.

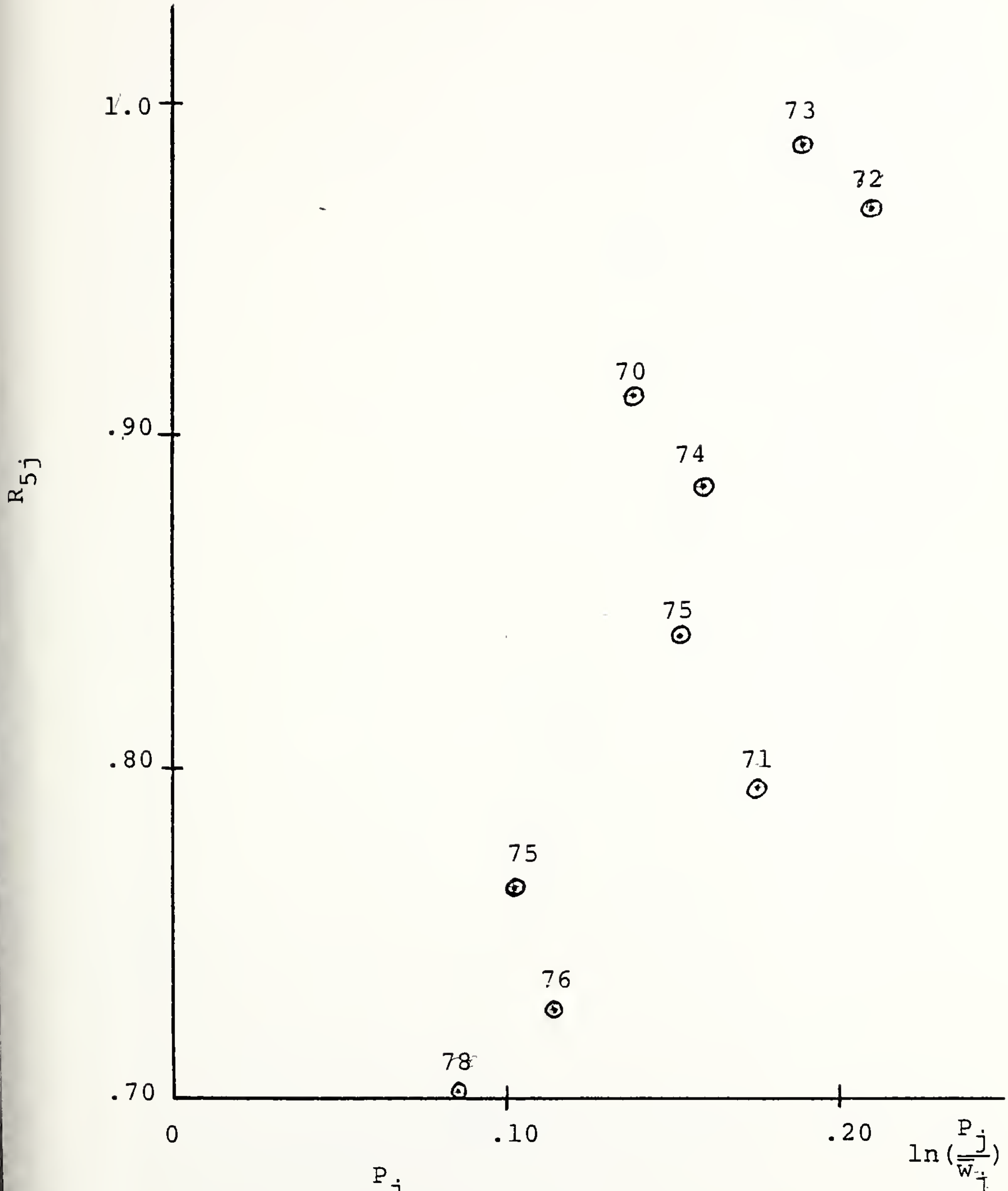

Figure 5: R_{5j} vs $\ln(\frac{P_j}{\overline{w}_j})$ (MODEL M1)

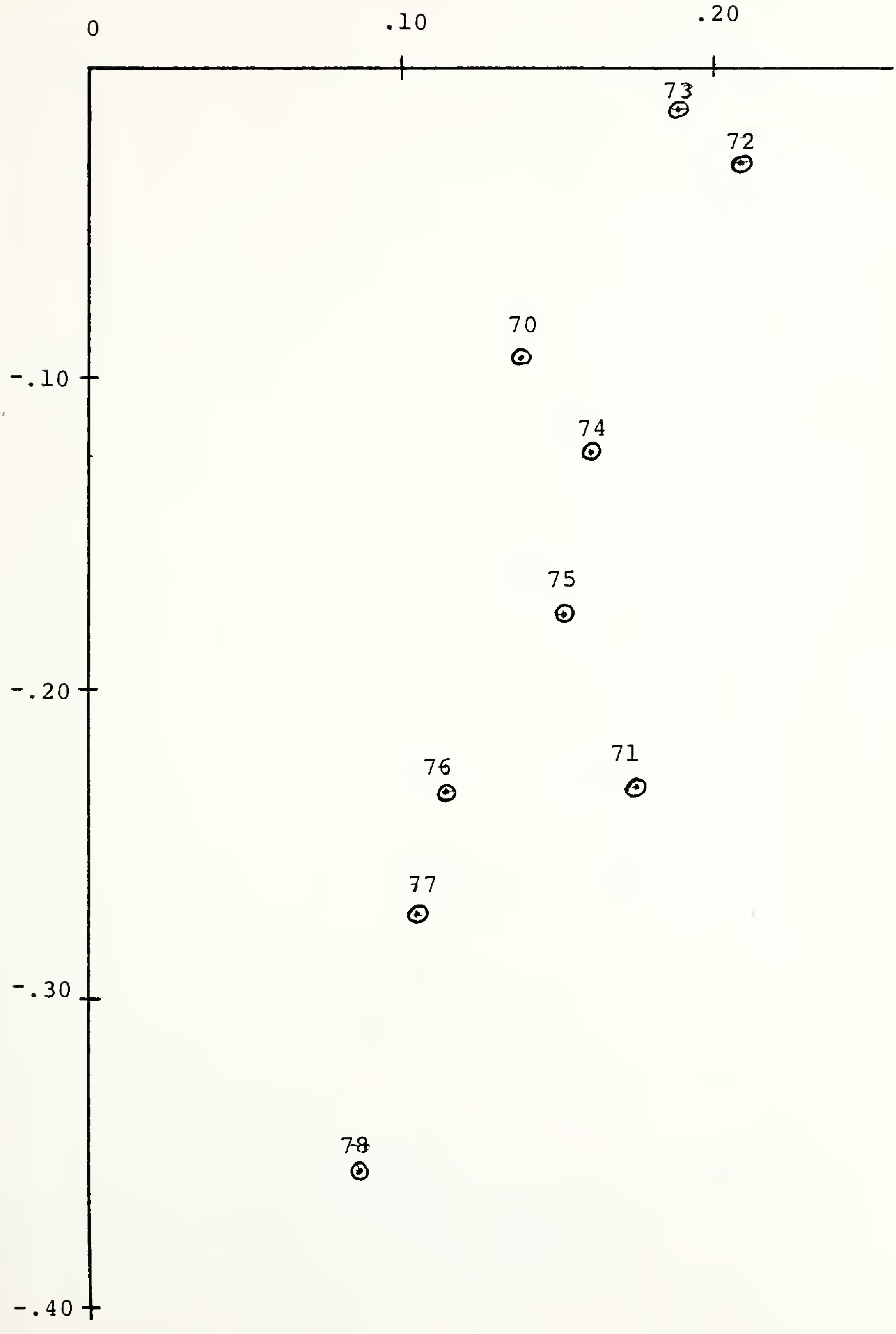

Figure 6: $\ln R_{5j}$ vs $\ln(\frac{P_j}{\overline{W}_j})$ (MODEL M2)

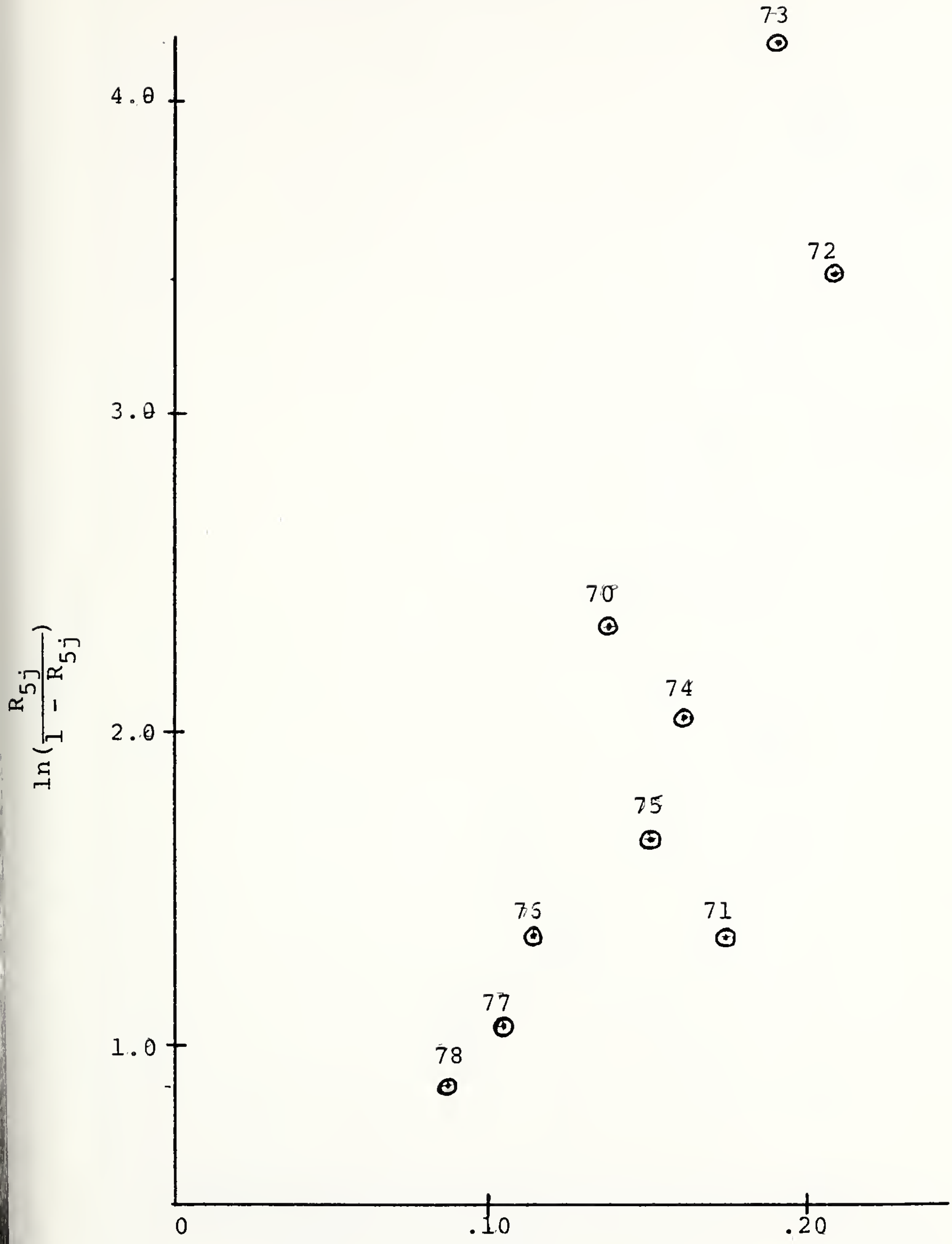

Figure 7: $\ln(\frac{R_{5j}}{1 - R_{5j}})$ vs $\ln(\frac{P_j}{\bar{w}_j})$ (MODEL M3).

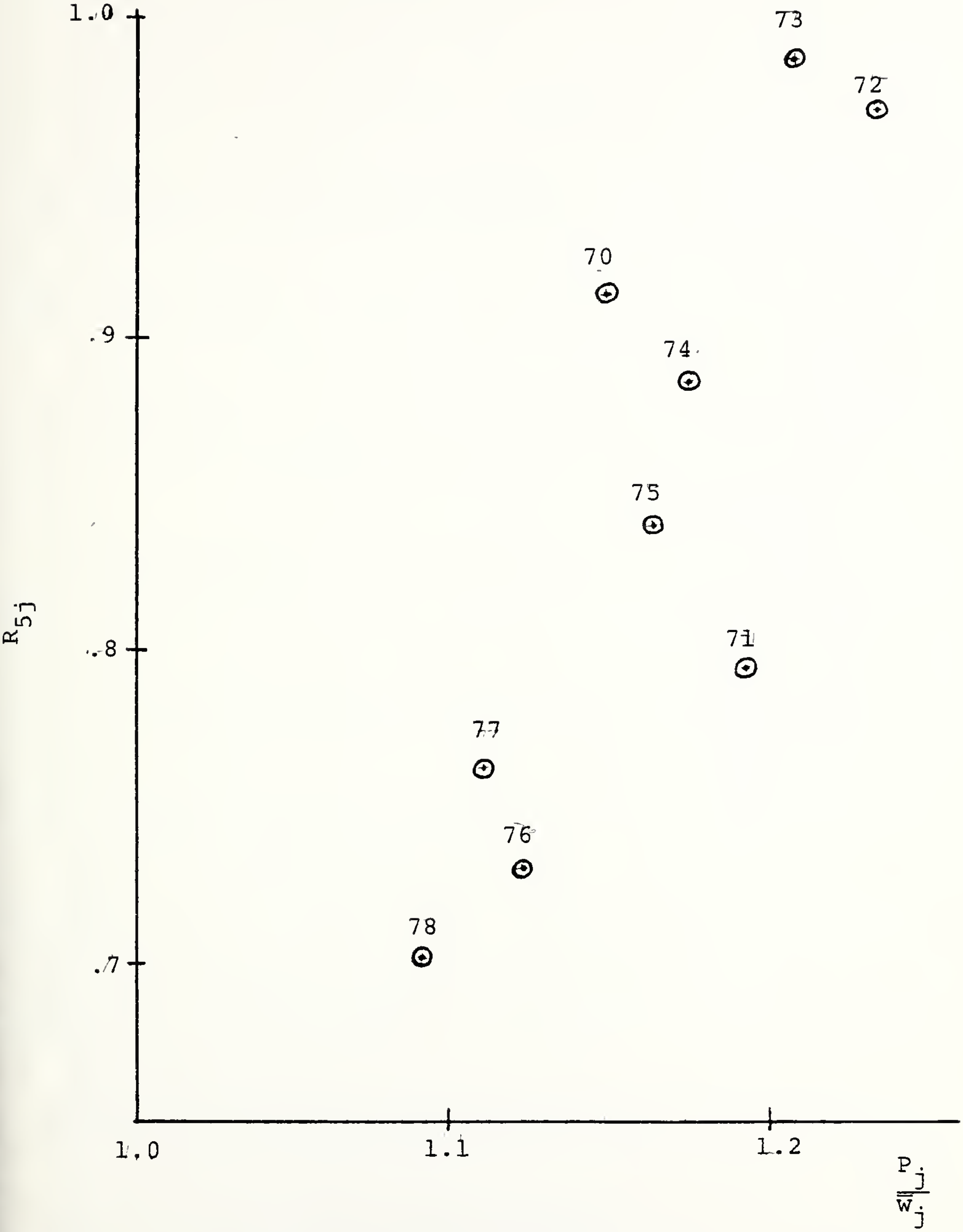

Figure 8: R_{5j} vs $\frac{P_j}{\overline{w}_j}$ (Model M4).

Table IV: Regression Results

GROUP	MODEL	R^2	SE	α	β	t_α	t_β	F	DW	N
SW4	M4	.631	.043	-.457	1.144	-.997	2.922	8.54	1.59	7
SW4	M2	.617	.049	-.357	1.462	-4.328	2.836	8.041	1.54	7
SW4	M3	.591	.811	-1.257	22.928	-.922	2.687	7.222	2.32	7
SW5	M4	.953	.025	-1.406	1.948	-6.269	10.057	101.14	2.521	7
SW5	M2	.955	.029	-.560	2.678	-14.257	10.283	105.74	2.374	7
SW5	M3	.819	.581	-1.501	24.828	-1.910	4.758	22.64	2.448	7
SW4,5	M4	.983	.021	-3.312	3.460	-12.401	15.288	233.73	2.175	6
SW4,5	M2	.993	.018	-1.164	5.382	-30.660	23.712	562.28	1.895	6
SW4,5	M3	.809	.588	-3.671	31.325	-2.884	4.115	16.94	2.831	6

A table of the 0.95 quantile of the F distribution specifies rejecting the null hypothesis (H_0: $\alpha = 0$ and $\beta = 0$) if $F_{m,n} \geq 6.61$ when m = 1 and n = 5. Thus, a reported F-statistic greater than 6.61 also supports a given model.

It should be noted that, while the R^2 statistic may be compared directly from one model to the next, the standard error (SE) is not directly comparable because of the different transformations applied to the dependent variables in each of the three models under consideration.

While reported Durbin-Watson statistics are not directly usable for reasons previously discussed, those statistics indicate, and separate Hildreth-Lu procedures support, independence between the j and j-1 observations on the dependent variable.

A group by group and model by model comparison of the statistical results indicates that M2 is superior to M4 and that M3 is clearly inferior to either M2 or M4. Also, comparing across groups, it will be noted that for each model, the SW4 group gives the poorest fit and the SW4,5 group gives the best fit. The marked difference across the groups warrants further explanation.

It was previously noted (Data Analysis, Section A) that the IOS requirement for USNA entrants changed from four to five years after the USNA class of 1968. Consequently, after 1972, the USNA officers with YS = 4 who desired separation from the service had to wait an additional year. The net effect of such a change in IOS would be to increase the retention rate for the

SW4 group and decrease the rate for the SW5 group.[11] A review of Figure 4 will illustrate this point. Thus, while it is felt that the SW4,5 and SW5 groups' retention data are not seriously affected by such a change in the USNA entrants' IOS, the SW4 group data are probably biased. That bias partially explains the poor fit for the SW4 group.

It is not the intent of this study to go beyond a retention model for "first term" surface warfare officers; however, additional retention data for all unrestricted line (URL) officers was obtained from OP130 for comparison purposes. Although the URL data is not identical in format and category to that of the surface warfare community since it includes non-due course officers, it is believed that some additional insight into the legitimacy of the three models, M2, M3, and M4, can be gained by performing regressions using those models on the URL data. The URL data was adjusted to net retention data using the same procedure as that for the surface warfare data before applying the regressions. The statistical results of the regressions are presented in Appendix D. It should be noted that since $\frac{P_j}{\bar{w}_j}$ does not include the special pay categories applicable to some URL officers, the use of P_j and $\bar{w}_j$ as instruments for PVM_j and PVC_j, respectively, probably increases the amount ~~of~~ unexplained variability.

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[11] In the regressions performed on the SW5 group, the problem posed by such a change in IOS was partially corrected by performing the regressions without the first two data points. Such an adjustment was not possible for the SW4 group.

D. ELASTICITY OF RETENTION

Define the elasticity of retention with respect to wage ratio as the proportional change in retention, $\frac{\Delta R}{R}$, divided by the proportional change in wage ratio, $\frac{\Delta(wr)}{wr}$.[12] Let E_R denote that elasticity so that:

$$E_R = \frac{\Delta R \ / \ R}{\Delta(wr) \ / \ wr} \tag{19}$$

In derivative form, (19) may be reexpressed:

$$E_R = \frac{dR \ / \ R}{d(wr) \ / \ wr} = \frac{dR}{d(wr)} \ \frac{wr}{R} \tag{20}$$

Removing the logarithmic transformation, M2, the best fitting model, may be written:

$$R = e^{\alpha} \ wr^{\beta} \tag{21}$$

Implicit differentiation of (21) yields:

$$dR = \beta \ e^{\alpha} \ wr^{\beta-1} \ d(wr) \tag{22}$$

or,

$$\frac{dR}{d(wr)} = \beta \ e^{\alpha} \ wr^{\beta-1} \tag{23}$$

Substituting (23) into (20) gives an expression for E_R based on M2:

$$E_R = \frac{\beta e^{\alpha} \ wr^{\beta}}{R} = \frac{\beta \ \hat{R}}{R} \cong \beta \tag{24}$$

---

[12] Actually, $wr_j = \frac{P_j}{W_j}$. The subscripts have been suppressed for ease of presentation.

Such a constant elasticity is not realized from model M4. Utilizing M4:

$$\frac{dR}{d(wr)} = \beta \tag{25}$$

and

$$E_R = \beta \frac{wr}{R} \tag{26}$$

Thus, E_R based on M4 varies as the ratio $\frac{wr}{R}$ so that E_R is greater than one when $\frac{R}{wr}$ is less than β and E_R is less than one when $\frac{R}{wr}$ is greater than β.

Table V gives values of E_R utilizing parameter estimates developed in the preceding section for models M2 and M4 and groups SW4, SW5, and SW4,5.

TABLE V

Elasticity of Retention, E_R

Group	Model	E_R
SW4	M2	1.462
SW4	M4	$1.144(\frac{wr}{R})$
SW5	M2	2.687
SW5	M4	$1.948(\frac{wr}{R})$
SW4, 5	M2	5.382
SW4, 5	M4	$3.460(\frac{wr}{R})$

V. CONCLUSIONS

A. POLICY APPLICATIONS OF THE RETENTION MODEL

Even though uncertainties exist regarding the accuracy of the data and the development of the models utilized, a relationship between the retention of junior surface warfare officers and their relative compensation level is apparent. The 1976 Defense Manpower Commission's [1] supposition that "...one serves regardless of recognition or appreciation," while perhaps true in former times, is no longer valid. The statement of the 1978 Commission on Military Compensation [2] that "...the Nation's supply of military manpower has become more dependent on the conditions of the labor marketplace" is supported by the results of this study.

The existence of a quantifiable relationship between retention and relative compensation level facilitates the analysis of the effect of various compensation policy alternatives _vis a vis_ a desired retention level. For purposes of illustration, suppose that a 5.5% military cost of living pay adjustment is proposed to compensate for a 10.5% annual inflation rate. Assume that the current annual retention rate of fifth year surface warfare officers (group SW5) is 0.7 and the current wage ratio is 1.09. Utilizing the elasticity of retention for group SW5 and model M2:

$$E_R = \frac{\Delta R \ / \ R}{\Delta(wr) \ / \ wr} = 2.678$$

or,

$$\Delta R = 2.678 \frac{\Delta(wr)R}{wr}$$

If the private sector also grants a 5.5% cost of living adjustment so that the median income level of white families (in current dollars) also changes by 5.5%, then $\Delta(wr) = 0$ and $\Delta R = 0$, i.e., retention rate remains unchanged.

However, if private sector productivity or worker bargaining power produces a greater than 5.5% pay adjustment, one would expect retention to decrease. Assume that the median income level matches the rate of inflation so that $\bar{w}_{(j+1)} = \bar{w}_j + 0.105\ \bar{w}_j$ and $\Delta(wr) = -.049$. Then,

$$\Delta R = 2.678 \frac{(-.049)\ (.70)}{(1.09)} = -.084$$

Thus, predicted retention ($R_{(j+1)} = R_j + \Delta R$) is 0.616.

B. MINIMIZING PERSONNEL COSTS

Given the current military pay structure, a raise in pay for junior officers results in a similar raise for the more senior ranks. Since cash compensation appears less important above the seventh year point in an officer's career, such a raise for the more senior officers might appear excessive. However, the regressions utilized in this study require that the military pay growth rate remain constant in order for the individual contemplating a career to estimate PVM. The effect on retention of altering the military pay growth rate to reduce the rate in the more senior ranks cannot be readily determined.

The results of this study suggest that to improve junior officer retention one must incur higher personnel costs in all ranks.

On the other hand, the failure to adequately compensate the junior ranks results in low retention and high replacement costs at the ensign level. Furthermore, if one accepts the premise that those officers with the greatest military potential generally possess the greatest civilian potential, the present value ratio, PVM/PVC, of the better officers is somewhat lower than that of a "typical" officer. Thus, a decrease in the present value ratio should result in a "quality" loss as well as a numeric loss.

Viewed in the larger context of total personnel costs, the relevant problem involves trade-offs between retention costs and replacement costs. The solution to such a problem requires the construction of a model which balances billet costs against acquisition costs in order to determine the retention vector that minimizes total personnel costs. The retention models developed in this study relate compensation levels to retention rates, providing one required link in the solution of the larger problem.

(YS=2)

FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	483	501	589	729	629	638	545	778	877	916	875	848
Bases	RES	469	1485	855	1072	576	298	163	326	487	468	325	490
	TOTAL	952	1986	1444	1801	1205	936	708	1104	1364	1384	1200	1338
Retirement		0	0	0	2	0	0	0	2	0	2	2	—
RAD		1	45	79	229	169	23	1	10	27	46	15	--
Resignation		0	0	1	7	1	1	0	6	2	14	6	--
Death		0	1	0	0	0	0	0	1	0	0	1	--
Discharge		0	0	0	2	1	0	0	0	1	3	1	--
Community Change		1	0	4	6	14	2	5	25	18	46	43	--
Other		0	2	1	4	5	1	0	2	0	7	4	--

APPENDIX A

(YS=3)

FISCAL YEAR

		69	70	71	72	73	74	75	56	7T	77	78	79
	REG	629	499	525	624	764	674	701	855	850	845	955	922
Bases	RES	283	453	1436	766	825	346	229	373	289	264	358	271
	TOTAL	912	952	1961	1390	1589	1020	930	1228	1149	1109	1313	1193
Retirement		0	1	4	2	2	0	3	0	0	1	0	--
RAD		22	119	1015	453	589	234	84	173	13	98	56	--
Resignation		1	4	5	5	25	19	9	25	18	22	26	--
Death		1	1	0	1	0	0	0	0	0	1	1	--
Discharge		0	0	1	0	3	0	0	0	0	0	2	--
Community Change		3	4	5	8	25	13	6	53	55	80	73	--
Other		0	5	15	3	2	1	0	1	2	5	12	--

APPENDIX A

(YS=4)

FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	422	648	528	540	668	795	696	975	863	809	786	964
Bases	RES	190	198	307	396	279	170	58	144	163	148	117	198
	TOTAL	612	846	835	936	947	965	754	1119	1026	957	903	1162
Retirement		0	0	2	3	5	1	0	1	0	1	0	--
RAD		6	35	170	131	105	59	18	60	8	59	39	--
Resignation		0	158	117	46	65	138	87	102	47	131	93	--
Death		0	0	0	1	0	0	1	0	0	0	0	--
Discharge		0	3	10	16	17	8	3	0	0	0	3	--
Community Change		9	3	5	3	14	24	10	44	11	33	43	--
Other		0	1	2	6	2	5	0	1	1	3	15	--

APPENDIX A

(YS=5)

FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	426	481	534	445	535	637	693	736	867	819	669	674
Bases	RES	129	158	156	114	188	84	52	32	71	72	45	48
	TOTAL	555	639	690	559	723	721	745	768	938	891	714	722
Retirement		0	0	4	0	1	1	0	1	1	1	2	--
RAD		8	27	57	39	74	28	20	40	2	23	26	--
Resignation		5	42	119	36	47	76	101	96	38	134	26	--
Death		0	0	1	0	0	0	0	0	0	0	0	--
Discharge		0	3	10	0	2	2	16	23	0	23	17	--
Community Change		9	6	11	4	21	17	17	18	12	38	45	--
Other		0	0	3	0	1	1	0	0	0	1	13	--

(YS=6) FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	441	451	438	424	431	527	563	581	584	545	624	470
Bases	RES	66	84	109	82	66	62	31	20	10	45	20	13
	TOTAL	507	535	547	506	497	589	594	601	594	590	644	483
Retirement		0	1	1	1	2	0	0	0	0	1	1	--
RAD		2	9	39	18	21	35	15	25	3	2	4	--
Resignation		6	19	66	29	31	60	50	49	28	83	102	--
Death		0	1	0	0	0	0	0	0	0	0	0	--
Discharge		0	0	0	0	1	0	0	1	0	0	0	--
Community Change		8	6	7	2	13	16	20	26	9	24	34	--
Other		0	0	2	2	0	0	4	0	0	0	6	--

APPENDIX A

(YS=7)

FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	536	445	437	394	428	413	451	502	495	461	429	483
Bases	RES	59	40	58	50	31	20	14	15	13	10	5	12
	TOTAL	595	485	495	444	459	433	465	517	508	471	434	495
Retirement		0	0	1	1	1	1	0	0	0	0	1	--
RAD		1	3	16	17	8	8	2	17	0	2	2	--
Resignation		6	19	31	19	13	18	35	42	11	49	35	--
Death		0	1	2	0	1	0	0	0	0	0	0	--
Discharge		0	0	0	0	0	0	1	0	0	0	0	--
Community Change		5	5	2	0	10	14	15	14	3	17	12	--
Other		0	0	0	0	0	0	1	0	0	0	3	--

(YS=8)

FISCAL YEAR

		69	70	71	72	73	74	75	76	7T	77	78	79
	REG	446	544	388	419	375	384	378	396	434	423	395	378
Bases	RES	34	40	28	33	27	15	5	4	9	16	3	2
	TOTAL	480	584	416	452	402	399	382	400	443	439	398	380
Retirement		0	0	3	0	0	0	1	0	0	0	0	--
RAD		0	1	7	7	8	4	0	5	0	4	2	--
Resignation		4	13	17	6	9	11	10	20	5	32	24	--
Death		0	0	1	0	0	0	0	0	0	0	1	--
Discharge		0	1	0	0	0	0	0	0	0	0	0	--
Community Change		4	2	2	0	5	8	8	12	6	10	11	--
Other		0	0	0	1	0	0	1	0	0	0	5	--

Appendix B

Accessions

YS/Year	69	70	71	72	73	74	75	76	7T	77	78
0	1315	1709	1097	941	615	563	1208	985	68	1030	1121
1	83	81	88	39	21	24	537	205	29	143	143
2	17	18	32	36	11	24	527	92	9	51	65
3	8	12	13	12	5	9	291	54	19	10	24
4	8	11	19	11	6	11	122	28	23	6	7
5	8	9	18	16	14	5	29	15	47	2	5
6	4	5	10	4	3	3	18	10	6	2	1
7	1	4	7	8	2	3	1	4	8	1	1
8	2	5	1	1	3	3	2	7	1	4	1
9	10	5	1	1	3	1	1	0	0	4	5
10	1	0	2	2	0	0	2	1	2	1	1

Appendix C

j	P_j	$\bar{w}_j$ [13]	$P_j - \bar{w}_j$	$\frac{P_j}{\bar{w}_j}$
67	15739	14039	1700	1.121
68	16002	14623	1379	1.094
69	16362	15208	1154	1.076
70	17231	15006	2225	1.148
71	17871	15001	2870	1.191
72	19374	15715	3659	1.233
73	19485	16134	3351	1.208
74	18163	15478	2685	1.173
75	17548	15091	2457	1.163
76	17412	15537	1875	1.121
77	17274	15560**	1714	1.110
78	17110	15700**	1410	1.090

[13] From <u>The Economic Report of the President</u>, January 1978.

** Estimated using current Labor Department statistics.

Appendix D

Group	Model	R^2	SE	α	β	t_α	t_β	F	DW	N
URL4	M4	.793	.025	-.267	1.013 1.194	-.983	4.371	19.10	2.89	7
URL4	M2	.791	.028	-.288	1.284 1.462	-6.047	4.351	18.93	2.93	7
URL4	M3	.587	1.019	-1.71	29.06 22.928	-.973	2.665	7.10	2.544	7
URL5	M4	.822	.021	-.175	.914 1.798	-.786	4.797	23.01	2.229	7
URL5	M2	.817	.023	-.297	1.174 2.672	-7.385	4.718	22.26	2.256	7
URL5	M3	.746	.342	.048	14.04 24.818	.081	3.834	14.69	1.979	7
URL4,5	M4	.828	.049	-1.563	2.016 3.910	-3.578	5.577	28.92	2.296	8
URL4,5	M2	.844	.062	-.716	3.069 5.382	-8.494	5.697	32.46	2.150	8
URL4,5	M3	.745	.416	-.872	15.215 31.325	-1.532	4.183	17.49	2.282	8

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